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RESEARCH REPORT NO. 34

MANPOWER GOALS PLANNING AND ACCOUNTABILITY

BY R.J. NIEHAUS
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NAVY DEPARTMENT
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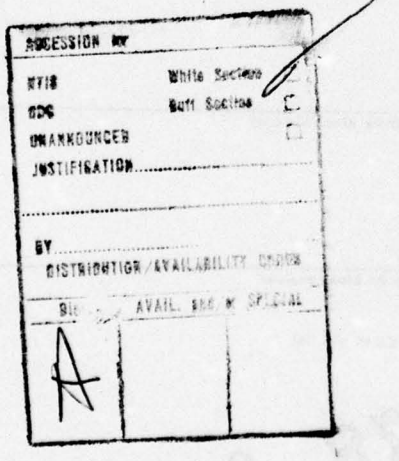
Extensive work has been done on the application of goal programming models to manpower goals planning for large organizations. The purpose of this paper is to structure the extensions from the planning process to the operations and control aspects of the management cycle. Emphasis is on the accountability necessary to make this type of system an effective management control system. In order to develop this extension, this paper briefly explains the Navy's system and progress to date. Then theoretical constructs of goals, planning, and accountability are discussed along with the general issues of management control system design as they apply to manpower planning. The issues are illustrated by means of numerical studies in the areas of organization-wide impact studies, EEO planning and accountability, and local installations models for borrowing and loaning personnel among cost centers.



OCP Research Report No. 34

MANPOWER GOALS PLANNING AND ACCOUNTABILITY

by

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April 1978

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Introduction

Extensive work has been done on the application of goal programming models to manpower goals planning for large organizations.[1] The purpose of this paper is to structure the extensions from the planning process to the operations and control aspects of the management cycle. Emphasis is on the accountability necessary to make this type of system an effective management control system. In order to develop this extension, this paper will briefly explain the system and progress to date, develop some theoretical constructs of goals, planning and accountability, discuss general issues of management control system design, and apply these to manpower planning. The issues are illustrated by means of a series of graphical and numerical examples.

Definitions of the terms used throughout the paper are in the particular sense made widespread by W. W. Cooper in his many applications on many fields with A. Charnes and others. They revolve around the plans-operations-control cycle of management. Although it is thought of as a sequential process, with planning at period 0, operations at period 1, and control at period 2, in reality all three take place continuously at all levels of an organization. However, either planning or operations can occur without the other. Plans can be further broken into two parts, that of developing "goals" which are ideals, and that of developing "plans" which take into consideration constraints and/or conflicting goals. This is particularly true if a

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[1] See Charnes, Cooper, and Niehaus [6] and Niehaus [17] for summaries and histories of the development of the model mathematics.

technique such as goal programming is to be integrated in and used to control the plans-operations-control cycle. Accountability takes on an additional meaning when supported by a model since the dynamic inter-related nature of the goals-plans pair can explicitly be taken into account when measuring the actions.

Another consideration is the rapid changes being made by mathematical and information technology in the decision environment itself.[3] Goals developed in one part of the organization may require plans in another part and actions in yet a third. This is particularly true for large organizations such as the U. S. Navy where manpower models are being institutionalized to fit the multi-level structure.[4] Additionally, with integrated systems of models and related reporting mechanisms, these multi-level systems may be tied together with a data communications network. This is particularly true for such applications as equal employment opportunity (EEO) planning and accountability.[5]

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2 For a summary of goal programming methodologies, see Charnes and Cooper [3].

3 See H. A. Simon [19] for an extended discussion on new directions of the decision sciences. Important earlier discussions can also be found in Cooper, Leavitt, and Shelly [9]; Rappaport [18], and Bonini, Jaedicke, and Wagner [2].

4 See Niehaus [16], and Cooper, Niehaus, and Nitterhouse [9].

5 See Charnes, Cooper, Lewis, and Niehaus [5], and Lewis [14].

Manpower Analyses and Planning

Preliminary to control and accountability is the need for an analysis of the underlying manpower statistics.[6] This analysis in turn can be used to shape the planning process.

The model computer support system was originally designed to be used for exception reporting.[7] The current system has a wide variety of features. In addition to special data analyses and impact studies, the system called the Computer-Assisted Manpower Analysis System (CAMAS) is used for recurring reports. It is also tied to other major Navy reporting systems such as those for equal employment opportunity planning and for military-civilian planning. The control system is tied into an advanced development research project examining local and intermediate command manpower planning. This system is called the Shore Activity Manpower Planning System (SAMPS). Extensive experimental work has been done on adaptation of the models for organizations of the size of 2,000-10,000 employees.

The initial U. S. Navy models developed by Charnes, Cooper and Niehaus [6] deal (at least formally) only with the planning process. They take as inputs, goals for various categories of personnel at various times in the future, the existing workforce configuration, historical or modified historical transition rates from category to category or out of the organization other goals (e.g., total workforce),

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[6] See Chapter II of Niehaus [15].

[7] See Chapter VII of [15].

the manager's set of relative "costs" for various personnel actions (hiring, firing, missing goals), average salaries and budget constraints. The output is that mix of personnel actions which will get as close as possible to the goals, given the assumptions, objectives, and constraints used.

For planning purposes, this use of the model facilitates management's assessment of the repercussions of considered actions, the sensitivity of outcomes to assumptions used, the impact of a changing environment, and the relative costs of some goals in terms of others. These uses, in turn, can lead to a better basis for planning as they improve management's understanding of the interactions of the world they are trying to manage. This type of planning can be useful even if the plans are never referred to once they are complete.[8] The process of planning itself is a learning tool for management to improve the organization's operations, and possibly to prepare them for contingencies or opportunities not otherwise anticipated.

An example of the use of a goal programming model for promotion planning is shown in Figure 1.[9] In this example, the impact of controls on the highest civil service pay grades (GS 13-18) was assessed. These controls, imposed by Congress in the 1978 Defense Appropriations Act, call for a reduction of the high grades of two percent each year for

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[8] For an example of such an application, see Charnes, Cooper and Niehaus [6].

[9] This model is an adaptation of the "flexibility" model for EEO reported in Charnes, Cooper, Lewis and Niehaus [4].

DEPARTMENT OF NAVY
OPPORTUNITIES FOR ENTRY INTO GS-13

SEP 71 - SEP 82

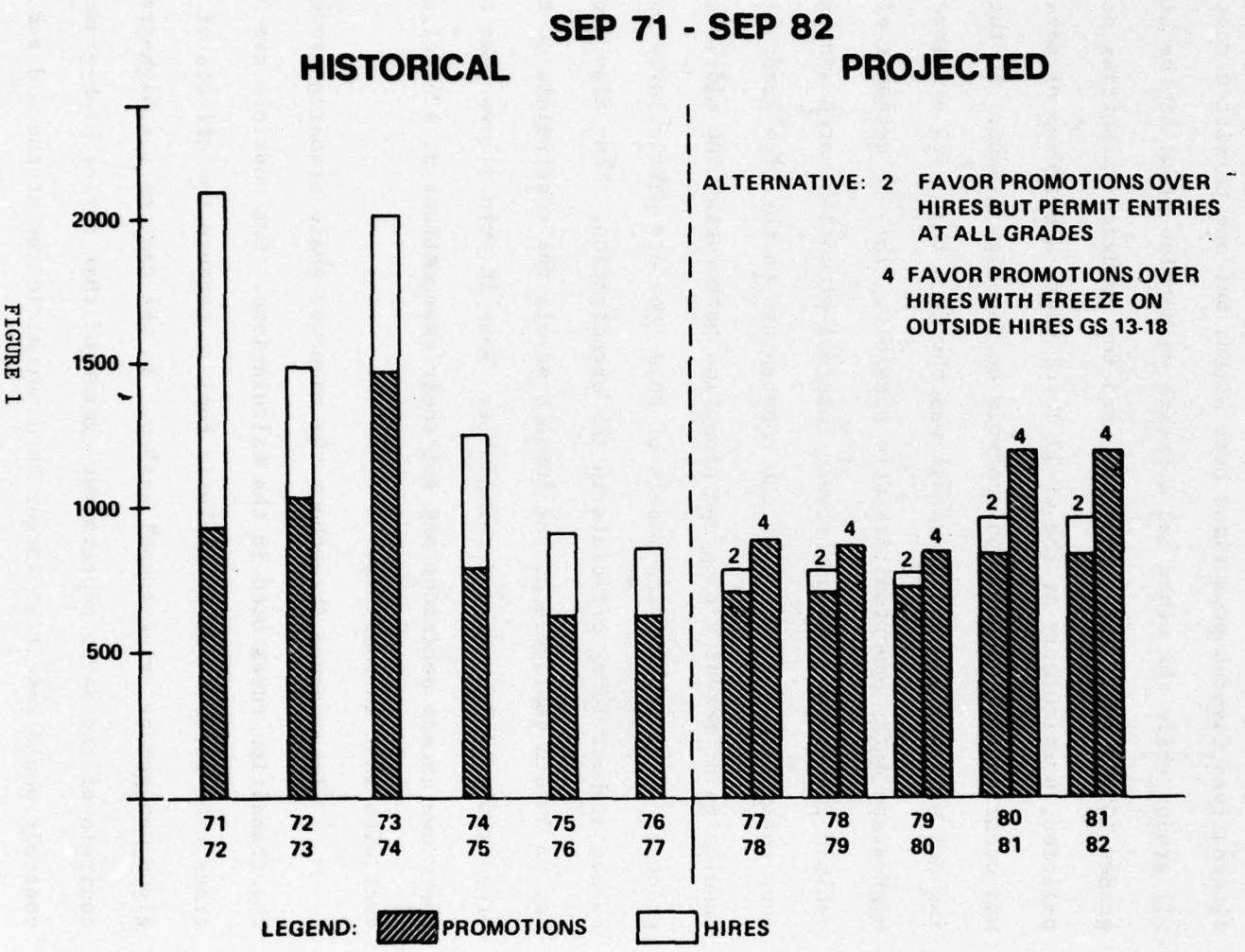

FIGURE 1

FY 78, 79, and 80. The data in Figure 1 show both historical promotions and hires for two other alternatives, which were calculated. Both alternatives favored promotions over hires, but one permitted entries at all grades while the other had a freeze on outside hires at the high grades (GS-13-18). This study was used for guidance in setting promotion policies, particularly at the GS-12 level where a build-up of personnel was occurring due to previous controls on the high grades. An interesting and somewhat unexpected result was the fact that with a freeze, more high-grade entry opportunities were possible. This is a result of the dynamic interrelationships between internal promotion rates and external loss rates (i.e., a change of the constraints on the high grade also results in different hiring and promotion patterns at the mid-level grades). Goal programming models of this type are particularly useful to the highest level officials in the organization. They also provide a way to inform employees of the impacts of all the constraints on the organization which are understandable. This in turn allows them to make their own career decisions and set their expectations at a level consistent with what is possible.

Interweaved throughout the manpower goals planning process are the transition rates used in the calculations. One possible use of transition rates is as an analytic tool to measure the effects of a given management or personnel policy. In the case of the high-grade controls of the Navy, concern was expressed that strict high-grade controls would result in larger than normal losses at the mid and lower grades. However, as shown in Figure 2, the controls had little or no effect on the Navy's losses of scientists and engineers. Probably, the

DEPARTMENT OF THE NAVY
LOSS RATES

SEP 71 - SEP 77

		SEP 71-SEP 72	SEP 72-SEP 73	SEP 73-SEP 74	SEP 74-SEP 75	SEP 75-SEP 76	SEP 76-SEP 77
Scientists & Engineers GS	5	.197	.248	.182	.119	.131	.153
	7	.155	.146	.155	.088	.104	.145
	9	.121	.111	.106	.071	.070	.097
	11	.100	.081	.079	.063	.056	.065
	12	.065	.071	.066	.054	.047	.056
	13	.072	.069	.064	.049	.050	.041
	14	.085	.090	.075	.061	.060	.044
	15	.085	.090	.098	.107	.095	.066
	16	.151	.132	.154	.202	.107	.050
	17	.461	.090	.153	-	-	-

FIGURE 2

more important factor during the 1971-1977 period was the slack labor market in almost all occupations. This is not to say that these transition rates should not be watched since the labor market for scientists and engineers is now becoming more competitive following the decline in enrollments in the engineering schools in the early 1970's coupled with increased demand.

Most of the model inputs discussed above are internally determined or generated. Conditions external to the organization may also be incorporated to improve planning and goal setting. The primary area in which this has been done is in the use of national, regional and/or local labor market data (as available) for determining EEO goals. Although goals are an input to the model, setting of these goals is an important part of the manpower management system. External factors can have a very strong impact, especially in the EEO area, on the feasibility or cost of meeting goals. For example, if EEO goals are set as proportional to the national ethno-sexual (race-sex) population alone, without consideration of either the regional or local population or the availability of particular ethno-sexual and skill combinations in the workforce, the goals may well be set at unreasonable levels, leading to discouragement and skepticism form the very beginning.[10]

Accountability and Control

Accountability is "the obligation for an employee, agent, or other person to supply a satisfactory report, often periodic, of action

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[10] See Atwater, Niehaus and Sheridan [1] for a discussion of labor market analysis for EEO.

or failure to act following delegate authority."[11] This can refer to an employee's accountability to a direct superior, or a corporation's accountability to stockholders for its financial performance or to the Federal Government or general public for its EEO efforts, etc. It may involve a direct two-party relationship, e.g., typically that between employee and supervisor, or a third-party reporting on a first party to a second party, e.g., the General Accounting Office reports on a Federal agency to the Congress. In practice, discussions of accountability usually concern formal (i.e., documented) reporting systems. Accountability is receiving increasing attention as a tool for control, especially in terms of public agencies being accountable to the public for their actions.

Control is the ability to influence events toward a preferred outcome.[12] Therefore, in considering accountability for control, it follows that the entity being reported to should have some mechanism for influencing the entity being reported on. It is also hypothesized that the very fact of being required to report acts as a signal to the person reporting that the activities being reported on are important. This would have to be empirically tested, along with different lines of reporting and report contents, before further statements could be made on the efficacy of merely requiring a report as a tool for control. Certainly, with the proliferation of reports which has accompanied the communication revolution, the reporting (or report reading) burden

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[11] See Kohler [12].

[12] For a particularly good discussion of W. W. Cooper's views on the subject, see [8].

should not be added without a good reason. However, where there is a direct superior/subordinate relationship, accountability is vital to control.

Since nothing ever goes quite "according to plan," it is important to examine the repercussions of different outcomes materializing. The importance of accountability arises immediately, for if a manager does not have to report the actual outcome, no one will ever know if the planned target were achieved or not. Conversely, if one never accounts for one's plans, it is difficult to evaluate the actual outcome, especially in the absence of some external criteria. Thus, at a minimum, there should be accountability for plans and actual outcomes.

Accountability for goals, as separate from plans, also becomes relevant when goal programming techniques such as those in the manpower modeling system are used. The example mentioned above, of making EEO goals proportional to the labor force mix rather than the total population mix, is an illustration of two very different goals which could be used in EEO planning. Unless which one is used is accounted for, internal managers and external parties alike will have difficulty understanding and evaluating plans.

Given that a set of goals is chosen, the modeling system is then used to determine "how close to goals we can plan to get" considering existing conditions, constraints, and priorities. If the results of initial efforts are not acceptable, model inputs are modified until results are acceptable to those responsible for plans, and this set of outcomes is then adopted as the plan. Accountability for one's plans is thus viewed as including accountability for underlying assumptions and

priorities as well as the final numbers. Accountability for actual results then involves reporting outcomes of operation after the fact.

Consideration of the impact of external factors can be particularly relevant to evaluating a manager's performance. Since plans are made with an expectation of particular conditions being present during the operating cycle, different actual conditions affect the feasibility of meeting plans. A postmortem assessment of plan assumptions versus actual conditions might involve, e.g., running the model with actual transition rates but with all other data the same as when planning was originally done. This would give "how close to goals one should have expected to get if one had known exactly what the transition rates would be." This is similar to the concept of flexible budgeting, which has been used in cost accounting for many years. Of course, since transition rates are affected by managerial action as well as by possible external influences, the assessment must still be made as to how much should be attributed to each.

Accountability during the course of operations can indicate where something is going well or badly, and an analysis of the underlying causes (i.e., were planning assumptions wrong or are plans not being followed?) can help find where corrections can be made or additional advantage can be taken of good circumstances. In some cases, planned targets may have to be changed, while in others corrective action may be able to be taken. Goals may also be found to be inconsistent with external criteria (e.g., actual labor force mix) because of poor initial estimates, which could lead to a revision of goals, plans and actions.

Uses of accountability in the U. S. Navy civilian personnel context will be illustrated by EEO applications which are now being implemented.[13] An integral part of an EEO information system must be concerned with accountability and control. To be effective, EEO planning must be part of the management and reward structure of the organization and hence of the information structure. EEO should be similar to other management-by-objectives systems where the managers correct idiosyncracies and "buy-in" to the goals or targets for which they become responsible. Both the local and corporate points of reference must be included. The geographic labor market is different depending on the occupations involved. Part of this labor market, particularly for the non-exempt clerical and blue collar occupations, is local. This implies that a "bottom up" process is required to develop the corporate EEO goals. At the same time, there is a need to take a "top down" or corporate point of view when overall impact studies are accomplished. In many cases, there is not the time nor the reason for readjusting all the detailed EEO goals of the organization when an analysis is being made. An example of such a use would be to include evaluations of EEO considerations in the case of capital budgeting planning. What is needed is a system that will keep the goals, plans, and actions in reasonable agreement with one another. Further, the system must fix accountability to reward successes and manage deficiencies.

EEO goals should be included with other management indicators such as profit targets or program milestone accomplishments. It is

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[13] See Chapter III and IV of [15] as well as [5].

clear that EEO affects the economic livelihood of the organization just as much as productivity or mission accomplishment measures might indicate. This is true not only from the negative concerns of avoiding litigation but also from the positive point of view of possibly improved employee motivation and productivity. In any event, EEO should be an integral part of the line business decisions.

From a system framework, the procedure is to first develop EEO goals for the local installations of the organization using the tools of labor market analysis and models. These data, in turn, are presented for review by the corporate headquarters. Modifications may be made to reflect capital or mission plans which are unknown to the local organization. After the necessary revisions at the different levels within the organization and review by the EEO and legal stalls, the goals become the targets for control purposes.

Models are useful at both the local and headquarters levels. At the local level, models can be used to assist in developing alternative action plans for those parts of the workforce which are recruited and developed locally. At the headquarters level, beyond career planning, the goals can be used to complete the analyses on acquisitions, headquarters promotion policies, etc. In this case, the models are used for impact analyses rather than detailed skills balancing.

The goals systems which finally evolved for the Navy civilian workforce is based on a combination of regional and national calculations. These calculations are accomplished hierarchically by major command to fix accountability. First, for each command, in each labor market the relevant labor market coefficients are used to calculate the goals for

all the large installations with 500 or more civilian personnel. Then, the remaining installations in a given labor market for that command are added together and if there are 500 or more total employees, the regional labor market coefficients are used to compute the goals. If there are fewer than 500 employees, this residual is added to the residuals from other labor markets. This sum of residuals is used with the national labor market coefficients to complete the coverage of the workforce.

Several reports are necessary for accountability and control purposes. The first is an accountability report such as is shown in Figure 3. This report shows how well an organization did in relation to its goals and also provides planning information. The data columns or the reports indicate:

- The actual on-board in each ethno-sexual category at the beginning of the five-year accounting period.
- The actual on-board in each ethno-sexual category in each job category at the most current time period.
- The EEO goal in each ethno-sexual category in each job category for the current fiscal year.
- The discrepancies between the EEO goals and the current on-board population. (This version of the report is developed annually at the end of each fiscal year. At other times during the year, these data are omitted.)
- The EEO goal in each ethno-sexual category in each job category at the end of the five-year period.
- The desired changes from the current on-board population at the end of the accounting period both in numbers and percentages.

EEO ACCOUNTABILITY REPORT
SAMPLE REPORT
BLACK MALE

OCCUPATION	LEVEL	ABOARD SEP 76	ABOARD SEP 77	GOAL SEP 77	DISCREP SEP 77	GOAL SEP 81	DESIRED CHANGE BY SEP 81 DIFF	DESIRED CHANGE BY SEP 81 PERCENT
SCI & ENG	GS 5-8	25	25	25	0	34	9	26.5
	GS 9-12	350	348	345	3	340	-8	-2.4
	GS 13-15	260	261	264	-3	297	36	12.1
	GS 16-18	2	2	2	0	3	1	33.3
OTH PROF	GS 5-8	23	24	25	-1	33	9	27.2
	GS 9-12	62	64	64	0	76	12	15.8
	GS 13-15	13	13	13	0	15	2	13.3
ADMIN	GS 1-4	2	2	2	0	2	0	0.0
	GS 5-8	151	174	189	-15	340	166	48.8
	GS 9-12	775	770	764	6	1,167	397	34.0
	GS 13-15	113	112	112	0	114	2	1.8
	GS 16-18	1	1	1	0	1	0	0.0
TECHNICIAN	GS 1-4	145	144	144	0	144	0	0.0
	GS 5-8	845	857	851	6	898	41	4.6
	GS 9-12	697	695	694	1	687	-8	-1.2
	GS 13-15	3	4	7	-3	24	20	83.3
CLERICAL	GS 1-4	913	972	1,056	-84	1,638	666	40.1
	GS 5-8	583	539	656	-67	913	324	35.5
	GS 9-12	15	18	17	1	25	7	28.0
OTHER GS	GS 1-4	609	612	615	-3	634	22	3.5
	GS 5-8	442	471	463	8	497	26	5.2
	GS 9-12	5	7	8	-1	22	15	68.2
TOTAL BLACK MALE		6,004	6,165	6,317	-152	7,904	1,739	22.0

FIGURE 3

Another factor which needs to be measured is the opportunities an organization had to meet the goals. For instance, after the goals were set, there may be constraints from higher headquarters which make it difficult to reach the goals. Also, a measurement may be made of how many opportunities for personnel actions were distributed among the various ethno-sexual categories. Figure 4 uses the transition rate program of the CAMAS system to develop the needed data. The data is sorted by ethno-sexual category within occupation-level. It shows for each ethno-sexual category in each occupation level:

- population at the start of the accounting period
- hires
- promotions
- other gains (i.e., lateral transfers from another occupation within the organization)
- total opportunities
- losses
- population at the end of the accounting period.

The percentage opportunity statistics are stated in terms of the totals for each occupational-level. A quick scan of the data can provide (1) which ethno-sexual groups are having personnel actions and of what kinds and (2) the percentage of the total that each ethno-sexual group is having of each personnel action. The percentages alone are not enough to measure the relative changes in the ethno-sexual groups. Goal information such as provided in Figure 3 is necessary to measure accountability since labor market statistics are relevant. The purpose of the opportunity report is to surface potential areas for further management

EEO OPPORTUNITIES REPORT

NAVYWIDE – FY77

ADMIN GS 9 –12

	ACTUAL SEPT 76	HIRES NO	HIRES %	PROMOTIONS NO	PROMOTIONS %	OTHER GAIN NO	OTHER GAIN %	TOT OPP NO	TOT OPP %	LOSSES NO	LOSSES %	ACTUAL SEPT 77
BLACK MALE	775	38	.030	66	.043	26	.033	130	.036	85	.029	820
HISP MALE	259	26	.020	10	.006	8	.010	44	.012	15	.005	286
OTHER MALE	273	21	.016	8	.005	10	.012	39	.010	15	.005	297
WHITE MALE	14,994	1,023	.808	778	.517	621	.797	2,422	.682	2,257	.785	15,159
BLACK FEMALE	563	12	.009	98	.065	18	.023	128	.036	45	.015	646
HISP FEMALE	48	1	–	14	.009	1	.001	16	.004	7	.002	57
OTHER FEMALE	49	2	.001	11	.007	1	.001	14	.003	9	.003	54
WHITE FEMALE	3986	142	.112	519	.345	94	.120	755	.212	439	.152	4302
TOTAL	20,947	1,265		1,504		779		3,548		2,874		21,623

FIGURE 4

SAMPLE REPORT

attention. It can also be used to "account for" how often managers take advantage of personnel action opportunities to attain EEO objectives.

The transition data are also shown on an EEO dynamic report such as indicated by Figure 5. On this report, the data are shown sorted by occupation-levels within each ethno-sexual category. In this case, all the losses and gains for each ethno-sexual group are shown with the internal losses in one occupational-level becoming internal gains in one or more other occupation-level(s).

Comparisons of current period transition rates with planned or prior period actual transition rates can be used by superiors to assess whether managers are using available personnel action opportunities to increase the rate of transition of minorities into job categories in which they are presently underrepresented (as evidenced by discrepancies from goals). Appropriate rewards or punishment meted as a result of these reports should influence managers to take desired actions. Of course, normal rules of statistical inference must be applied to support statistical conclusions taken from the data.[14] However, even in the absence of "statistically significant" inferences, these reports serve as a basis for comparisons between managers and discussion of areas and methods of improvement.

Integrated Systems

The EEO applications are but one kind of integrated system which can be supported by a system of relating manpower goals, plans,

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[14] For an indepth discussion of statistical inference in relation to EEO, see J. Ledvinka [13].

EEO DYNAMICS FOR THE PERIOD MAR 75 TO MAR 76
ALL NAVY

OCCUPATION CATEGORY	GRADE GRP	ON BRD MAR 75	LOSSES				GAINS				ON BRD MAR 76
			INTERNAL	%	EXTERNAL	%	INTERNAL	%	EXTERNAL	%	
SOCIAL CATEGORY: BLACK MALE											
SCI AND ENG	GS5-9	24	11	45.8	4	16.7	7	29.2	8	33.3	24
	GS9-12	345	11	3.2	25	7.2	15	4.3	16	4.6	340
	GS13-15	279	12	4.3	16	5.7	16	5.7	1	.4	268
	GS16-18	2			1	50.0					1
OTHER PROFESSIONALS	GS5-8	21	11	52.4	1	4.8	3	14.3	11	52.4	23
	GS9-12	44	4	9.1	3	6.8	11	25.0	4	9.1	52
	GS13-15	12	1	8.3	1	8.3	1	8.3	1	8.3	12
MANAGERS AND ADMIN	GS1-4	11	5	45.5	5	45.5					1
	GS5-8	188	60	31.9	16	8.5	35	18.6	23	12.2	170
	GS9-12	690	29	4.2	60	8.7	108	15.7	32	4.6	741
	GS13-15	114	4	3.5	13	11.4	12	10.5	3	2.6	112
	GS16-18	1									1
SUB PROF AND TECH	GS1-4	143	48	33.6	22	15.4	13	9.1	43	30.1	129
	GS5-8	795	110	13.8	61	7.7	108	13.6	69	8.7	801
	GS9-12	629	37	5.9	37	5.9	89	14.1	34	5.4	678
	GS13-15	4	1	25.0							3
CLERICAL	GS1-4	890	121	13.6	175	19.7	56	6.3	180	20.2	830
	GS5-8	587	63	10.7	50	8.5	72	12.3	26	4.4	572
	GS9-12	16	1	6.3	1	6.3	1	6.3	1	6.3	16
	GS13-15	1	1	100.0							
SERVICE	GS1-4	505	84	16.6	116	23.0	8	1.6	217	43.0	530
	GS5-8	373	17	4.6	33	8.8	74	19.8	12	3.2	409
	GS9-12	3					2	66.7	1	33.3	6
TOTAL BLACK MALE		5,677	631	11.1	640	11.3	631	11.1	682	12.0	5,719

SAMPLE REPORT

FIGURE 5

and actions. There are multi-linked systems which tie together organization elements at the same level. There are also multi-level systems which tie together different levels of decision-making. These kinds of systems are particularly relevant to large local installations (2,000 or more employees) and higher headquarters.

Top managers of individual installations may be concerned with the details of the workforce beyond those currently supplied by the system. This necessitates cross-checking or linkage with a more detailed personnel system. Specific questions about training, shifting skill mix needs, and workload projections are relevant at this level and lower. At the level of the next higher manager, who has several of these installation heads reporting to him the types of questions change. In at least one case, the interest at this headquarters level is in evaluating and controlling the performance of those installation heads in managing their workforces, rather than in directly planning for workforce management. Aggregate workforce data is also useful at this headquarters level in policy discussions with closely related managers at the same hierarchical level. Detailed data is not generally appropriate. Thus, the management task of the position dictates, to some extent, the appropriate information.

The situation mentioned also involves a highly decentralized management in the headquarters position. If, because of individual management style, organization tradition or the characteristics of the specific position, there was a more centralized manager, the information needs (or at least requests) might be very different. No matter how centralized, however, it is not likely that the higher level manager

could use all the information in the same detail as could the installation managers below him. In general, as information flows up the organizational hierarchy, it becomes more summarized or aggregated and thus less detailed, but covers a much broader base. Thus, information needs may vary with hierarchical level (i.e., the position in the organization structure), with the degree of centralization/decentralization and the type of organization structure, and with the management style of a particular incumbent.

The issues of goal congruence between different organization levels also need to be addressed. In many cases, information about lower levels, which was not easily accessible in the past, is now available to higher levels of management. This may eliminate some of lower management's opportunities to build in slack or to build power on the basis of exclusive possession of information. As such, this wider dissemination of information may be perceived as detracting from lower management's prerogatives. This jealousy of information will probably be increased insofar as goal congruence between two contingent levels decreases. If manager A, who is subordinate to manager B, has goals which are not congruent with B's goals, A is likely to want to keep information about these goals and their accomplishment from B. This statement is made on the premise that B, as A's superior, is likely to punish A for pursuing goals which are incongruent with B's own. If A's pursuit of such incongruent goals is disclosed by a new information system, A's own goal accomplishment may be expected to be decreased. This type of problem could well lead to system sabotage if not anticipated and handled properly, even when overall benefits would have been positive to the organization.

If manpower models are to be used, they must be built into the management structure so that judgemental information is integral to the decision system.[15] Many of the earlier research applications of the Navy's Civilian Manpower Modeling Programs involved systems of this type. In this paper, discussion will be limited to a test of a multi-linked model in the cost centers of the Naval Air Rework Facility (NARF) in San Diego.[16] The purpose of this test was to see (1) a technical evaluation of the consistency between the two models; and (2) the management significance of the data.

Inside a large installation, much of the planning is accomplished by departments or cost centers. In this case, there are a number of organizations linked by the common fabric of the total installation. The cost center manager either makes or substantially influences the critical decisions of hiring, firing, and promotions. Considerable borrowing and loaning of personnel between cost centers may also take place. Structural rigidities such as a minimum number of personnel of a given kind needed in a cost center to perform its job or mission also should be considered. At the same time, these sub-unit levels plans need to fold into and be consistent with the total installation plan. Finally, it is desirable that planning models at the total installation level can be run without including all the cost center detail and be reasonably consistent with the sum of all the detail.

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15 For a discussion of a system of this type proposed for the Naval Laboratory System, see Cooper, Niehaus, and Nitterhouse [10].

16 See Chapter V of [15] and [11].

As might be expected, there is an explosion of detail when the cost center model is used. To show the comparison between the cost center and the NARF-wide models, only one occupation, aircraft electrician will be used. These data are given in Figure 6. Comparisons are provided of total strengths, hires and fires, goal deviations, and multi-period effects. Inter-occupation transfers which may account for some of the differences are not included in the comparisons.

From a consistency point of view, the differences are the key comparisons. Looking at the projected population data, one can see that the cost center model with the exception of the December 1976 period ends up with more personnel in each period. This is due in part to the fact that the model does not explicitly make inter-cost transfers. However, these numbers are most likely more realistic since the workload and hence structural requirements would not permit wide-scale transfers in any case. The hires and fires data has to be examined together since the single installation model will only reflect the net amount. In this example, the net amounts are always greater in the cost center model again for structural reasons. The greatest difference between the two models is in the goal deviations. Most of this can be accounted for by the need in the cost center model to make considerable adjustments because of the wide swings in workload in the cost centers.

A comparison of the total man-quarter data is shown in Figure 7. Both models overshot the total workload requirement when summed up for all four quarters. The cost center model overshot by 1.05% while the single installation model overshot by 0.15%. The comparison between the two models show them to be highly consistent, coming very close to the workload requirements, and each useful in its own right.

NAVAL AIR REWORK FACILITY, SAN DIEGO
AIRCRAFT ELECTRICIANS

MODELS RUN AS OF JUNE 1976

	Initial Population June 1976	Projected Population	Hires	Fires	Workload	Workload Deviations
					SEPTEMBER 1976	
Cost Center Model						
920	72	70			70	
930	22	24	3		24	
940	215	244	35		245	-1
950	188	173		9	173	
960	5	5			5	
TOTAL	502	516	38	9	517	-1
NARF-WIDE MODEL	502	513	26		517	-4
Difference		3	12	9		-3
					DECEMBER 1976	
Cost Center Model						
920		70	2		70	
930		23			24	-1
940		240			241	-1
950		159		8	152	7
960		5			5	
TOTAL		497	2	8	492	5
NARF-WIDE MODEL		499			492	7
Difference		-2	2	8		-2
					MARCH 1977	
Cost Center Model						
920		78	9		78	
930		23			24	-1
940		238			230	8
950		156			156	
960		5			5	
TOTAL		500	9		493	7
		493			493	
Difference		7	9			7
					JUNE 1977	
Cost Center Model						
920		76			90	-14
930		25			24	1
940		241	9		241	
950		153			130	23
960		5			5	
TOTAL		500	9		490	10
NARF-WIDE MODEL		490	6		490	
Difference		10				10

KEY: 920 No 2 Division
930 Hydrauiic/Mechanical Division
940 Avionics Division
950 No 1 Division
960 Power Plant Division

DETAILED COMPARISONS
OF COST CENTER AND SINGLE INSTALLATION MODELS

FIGURE 6

NAVAL AIR REWORK FACILITY, SAN DIEGO

AIRCRAFT ELECTRICIANS

MAN-QUARTERS
MODELS RUN AS OF JUNE 1976

	SEP 76	DEC 76	MAR 77	JUN 77	YEAR TOTAL
Workload Requirements	517	492	493	490	1992
Population Projections:					
Cost Center Model	516	497	500	500	2013
NARF Wide Model	513	499	493	490	1995

DIFFERENCES:

Cost Center Model 21 or 1.05%
NARF Wide Model 3 or 0.15%

TOTAL MANPOWER COMPARISONS
OF COST CENTER AND SINGLE INSTALLATION MODELS

FIGURE 7

The management uses of the data are considerable. If Figure 6 is re-examined, it can be seen that the workload of the No. 2 Division has increased from 70 to 90 aircraft electricians with the increase coming in the last two periods. At the same time, the workload of the No. 1 Division had declined from 173 to 130 aircraft electricians. The Avionics Division remained pretty much the same except for a dip in the March 1977 quarter. The other two cost centers which are small did not have much of a workload change. These data are all inputs to the model.

It is worthwhile to examine the cost center model outputs as far as hiring, firing and internal transfers are concerned. In the September 1976 period, the logical management action is to transfer the 9 redundant aircraft electricians in the No. 1 Division permanently to the Avionics Division. A total of 27 new personnel would need to be hired leaving a shortfall of only man-quarter in the Avionics Division. In the December 1976 quarter, two of the redundant eight personnel in No. 1 Division should be permanently transferred to the No. 2 Division and six laid off. In addition, from the No. 1 Division, one person should be temporarily loaned to the Hydraulic/Mechanical Division and one loaned to the Avionics Division.

Similar kinds of actions should be taken in the final two quarters. In the March 1977 quarter, the eight aircraft electricians over requirements in the Avionics Division should be temporarily loaned to the No. 2 Division. This leaves at this iteration, one person to be hired in the No. 2 Division and a shortfall of one in the Hydraulic/ Mechanical Division. In the final June 1977 quarter, care has to be taken to make sure the numbers are correct. The projected population is

492 as of March 1977 rather than 500, since only one rather than nine aircraft electricians were hired. Also, the remaining one extra person in the No. 1 Division cost center and one extra person in the Hydraulic/Mechanical Division should be loaned to the Avionics Division. In addition, seven aircraft electricians should be hired in the Avionics Division.

An installation summary of all the suggested actions is shown in Figure 8. December 1976 is the troublesome quarter. A suggested solution with no layoff would be to work overtime to carry out 12 man-quarters of the workload in the September 1976 quarter. This would smooth the workload with an overtime rate of a little over two percent. The model should be rerun with this decision in mind to fine-tune the required actions.

The cost center model is particularly useful in skills balancing. It not only addresses the issues of attrition and hires but also of borrows and loans. Further, the relationships of overtime scheduling and contracting out can be easily included.

In summary, the cost center model is particularly suited for:

a. Negotiating for rescheduling of assignments

b. Negotiating for additional or less workload

c. Establishing future employment levels compatible with the forecasted workload

d. Arranging for temporary hires or loans

e. Revising future training requirements including input levels.

NAVAL AIR REWORK FACILITY, SAN DIEGO

AIRCRAFT ELECTRICIANS
MODELS RUN AS OF JUNE 1976

	Projected Population	Hires	Fires	Workload	Workload Deviations
SEPTEMBER 1976	516	27		517	-1
DECEMBER 1976	497		6	492	5
MARCH 1977	492	1		493	-1
JUNE 1977	490	7		490	

INSTALLATION SUMMARY OF SUGGESTED WORKLOAD AND PERSONNEL ACTIONS

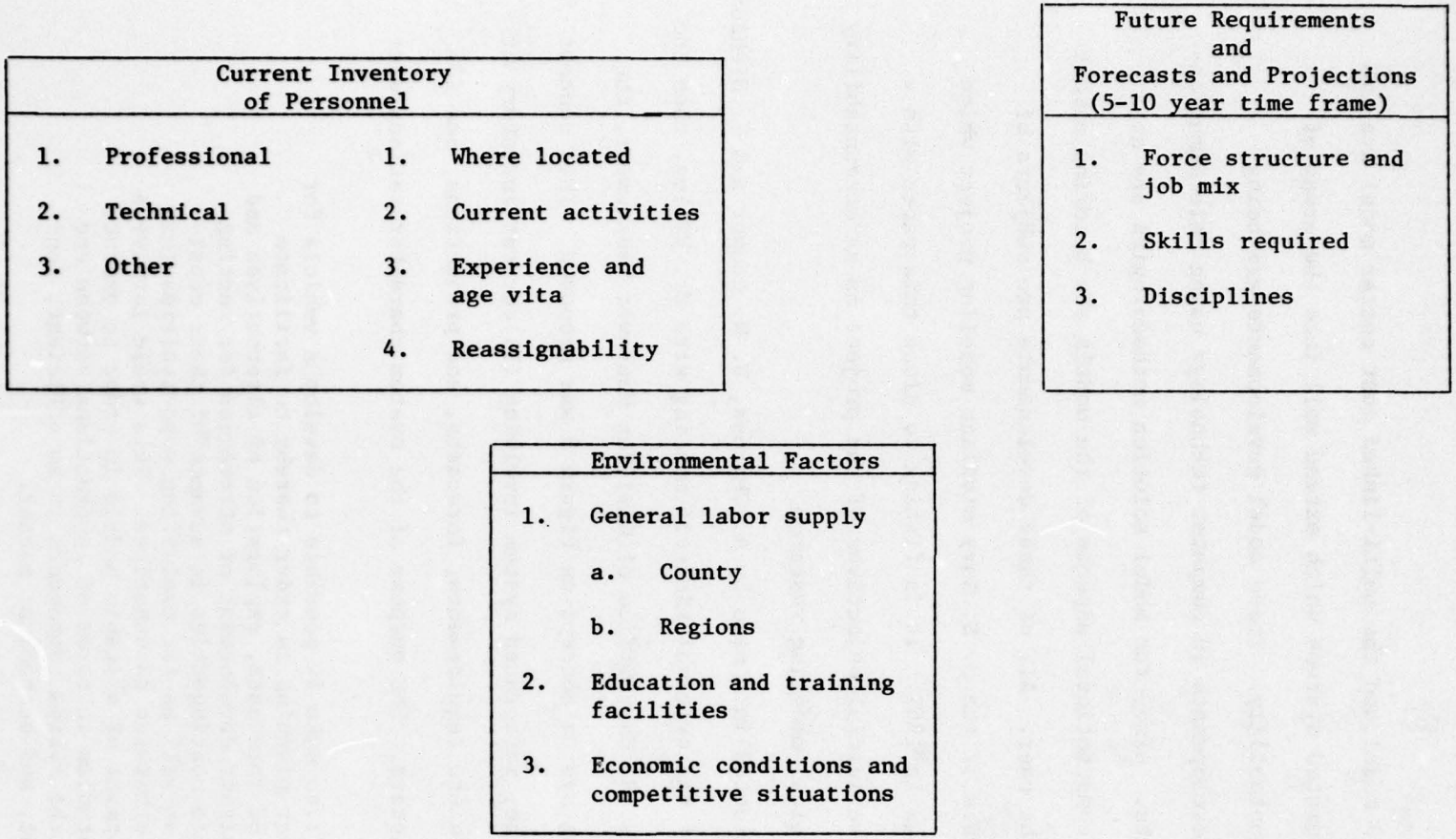
FIGURE 8

Conclusion

The EEO model and the multi-linked cost center model are two examples of integrated systems which extend well into the areas of control and accountability. These model developments are being parallelled by developments in computer technology using telecommunications arrangements. Also, the model solution methodologies are at a stage where the computational aspects of the models are becoming almost transparent to the user. All of these developments are subjects of continuing projects of the U. S. Navy civilian modeling project which had its beginnings in 1967. It is fitting to close this paper with a restatement of the initial objectives of the project as an accountability check on the original modeling research.

As reflected in a memo by A. Charnes, W. W. Cooper and R. Niehaus on the minutes of the original kick-off meeting with Mr. Willey, then the Director of the U. S. Navy Office of Civilian Manpower Management, the manpower planning system concept on Figure 9 was proposed. This concept envisioned a large, integrated system involving (1) current inventory of personnel, (2) future requirements, forecasts, and projections, and (3) environmental factors. The purpose of the system characterizations was:

> ...to make it possible to develop a vehicle for manpower planning in order thereby to facilitate study of forecasts, exploration of alternatives and a resultant development of strategies for meeting possible contingencies in advance of their occurrence as well as for exploiting opportunities that might otherwise go unnoticed. This would involve a development of suitable models in order to execute such studies in terms of interactions between and among the system components in an efficient, convenient, and economical manner.



1967 SYSTEM CONCEPT FOR U. S. NAVY CIVILIAN MANPOWER MODELING

FIGURE 9

Major management systems either exist (many in their second or third generation) or are in large-scale development in all the areas envisioned in 1967. Some of these applications were described in this paper. Perhaps the more interesting fact is the original team is still together using the system, now in place as a springboard for still further extensions. These extensions such as those into control and accountability represent the bringing together of yet other areas of management with the integrated system coming into place.

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